PLANTERS' BULLETIN

OF THE RUBBER RESEARCH INSTITUTE OF MALAYA

PLANTERS' BULLETIN FIFTY-SEVEN

CONTENTS

	Page
Editorial: Wind Damage	173
Mixed and Compound Fertilisers	175
Loss of Ammonia from Surface Application of Urea Fertiliser	180
Cover Plants, Manuring and Wind Damage	183
Substitutes for Sodium Arsenite	189
Notes, R.R.I. News	174, 191-195
Index, 1960–61	196

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CORRESPONDENCE. All LETTERS must be addressed to the Director, Rubber Research Institute of Malaya, Post Office Box 150, Kuala Lumpur. Special enquiries may be marked for the attention of particular officers. The address for TELEGRAMS is Searching, Kuala Lumpur. TELEPHONE: Kuala Lumpur 72051. PARCELS occasionally arrive without any indication of their origin. Senders' names and addresses should be written clearly on the outside of all packages, and advice of despatch should be given by letter or telegram.

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ADVICE. Enquiries are invited from rubber producers in the Federation of Malaya, Singapore, Nigeria, the colony of North Borneo, and the territories of Sarawak and Brunei, who may require more detailed information applicable to their own special problems. Where it is considered necessary, visits will be made to estates in Malaya as convenient. Visits to estates in other territories are by special arrangement. The only visits for which charges are normally made are those of our clone indentification inspectors. INTERVIEWS should be arranged by letter, as members of the senior research and advisory staff are frequently absent on visits to plantations.

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OF THE RUBBER RESEARCH INSTITUTE OF MALAYA

Kuala Lumpur November 1961 Number 57

Editorial: Wind Damage

The article 'Cover Plants, Manuring and Wind Damage' in this issue deals with susceptibility to a particular form of wind damage under certain circumstances, namely the tendency of some clones to bend and even break while still immature and the way in which this weakness may be accentuated by the shading out of vigorously growing leguminous covers with a consequent release of plant nutrients to the soil. The article offers tentative recommendations to alleviate this difficulty by modifications of manurial policy. The Soils Division of the Institute is making further studies and it is probable that more definite recommendations will be available in the course of time.

There are, however, other forms of wind damage for which preventive and remedial treatments are sought. For example, pruning of the young trees has been reported to prevent damage of the type described in the current article and to reduce trunk-snap incidence in the mature period. Branch breakage in particular might be avoided by modifying the shape of the tree to produce a good, balanced branching habit and to eliminate heavy forks arising at a narrow angle.

Trunk-snap of tapped trees is a more complicated problem in that the balance of the tree appears to be affected by reduced girth increments associated with high yields. If previous experience with a high yielding clone has shown that its girth increment is small when tapped, it would be advisable to delay opening to allow extra girthing. There are indications that periodic tapping systems allow better girth increments during the rest periods, so that the tendency towards imbalance may be reduced at some sacrifice of yield per acre, but with a better yield per tapper.

The variation in timber strength in various clones, in trees grown under different conditions and within the individual tree, has been investigated in static bending tests. The modulus of elasticity (proportionate to the force required to bend) and the modulus of rupture (proportional to the force required to break) have been determined and are closely correlated in most cases. These measures of timber strength, in conjunction with determinations of girth and the distribution of weight in the tree, have shown that the 'imbalance' theory is the best explanation so far available, although it is not completely satisfactory. According to this theory the balance of the tree is impaired, and resistance to wind damage consequently reduced, when there is an increase in the weight of the canopy without a compensating increase in the girth of the trunk.

One may enquire why the susceptibility of certain clones was not detected earlier, before recommendation for use on a wider scale. The failure to detect wind susceptibility in RRIM 501 is explained by the late opening of this clone at a girth of 25 in. or more, following the interruption of normal trial procedures during the war. Opened at this girth, the clone suffered little wind damage in its original large scale trials. It was only when the clone was tapped at a girth of 20 in. in the first commercial plantings that susceptibility to trunk-snap, consequent upon a check in girth increment, was observed. Imbalance owing to restricted girth increment had not been suspected before, but now that the risks are more clearly understood observations can be directed towards the early detection of any such tendency.

The form of the tree is important and a study is therefore required of the branching habit of new selections. However, as clones are more extensively planted so greater variation in habit is often found. For example GT 1 has been extensively planted in Indonesia for many years and more recently an increasing acreage has been planted in Malaya. The first trials in Malaya showed the well balanced crown development considered typical of GT 1 in Indonesia, but it is now observed that quite frequently large proportions of the trees show either 'bottle brushes' or heavy first forks. This may be related to environmental factors which are first encountered when the range of a clone's use is greatly extended. As yet, no wind damage has been reported in GT 1, but the unexpected appearance of these undesirable branching characteristics has caused some anxiety and shows that assessment of crown development on limited quantities of material may be deceptive.

At the Planters' Conference, willingness to help in collecting more extensive data on wind damage incidence was expressed by many participants. Commercial plantings of interest throughout Malaya have now been registered by the R.R.I.M. with the object of securing records of the performance of planting material. A preliminary survey of wind damage incidence will be conducted through these contacts. However, there may be others who have noteworthy cases to report: for instance, adjacent areas of the same clone showing marked differences in the incidence of wind losses which may be attributed to differences in topography, soil type, planting system, manurial history or husbandry. Isolated pieces of information of this nature are not always of much value on their own, but if all will contribute what they can, we should obtain a much clearer picture than we now have of the influence of environmental factors on the incidence of wind damage.

Proceedings of the Natural Rubber Research Conference, Kuala Lumpur, 1960 — The printed *Proceedings* of this Conference are available from the R.R.I.M. All papers and discussions are reported in full. The price is $23.00 (Malayan) plus cost of postage and packing as follows: $1 within Malaya; $2 (book post) or $5 (parcel post), outside Malaya.

Mixed and Compound Fertilisers

OVER THE PAST FEW YEARS, a number of new fertilisers have appeared on the Malayan market and have been offered to rubber growers for use in their immature and mature areas. In many cases, supplementary literature has been distributed describing the benefits of this or that brand and the Rubber Research Institute has consequently been asked to comment on the suitability of the materials and the claims made for them. In most cases, answers based on the results of research findings can be given to the individual enquirer, but a general review of the advantages and disadvantages of the different materials available will probably help many growers to understand the present position.

The bulk of fertilisers used by rubber growers consists of mixtures manufactured in Malaya according to R.R.I.M. formulae from ingredients imported in bulk. Sulphate of ammonia is the principle source of nitrogen, rock phosphate supplies the phosphate, muriate of potash the potassium, and kieserite (sulphate of magnesium) the magnesium. Eight principal mixtures are used, namely R.R.I.M. mixtures M, C_2, X and Y, all four with and without magnesium, and these have been found to give satisfactory results on most soils. Schedules of manuring have been given for these mixtures in *Planters' Bulletin 35*, page 42.

The fertiliser trade is however influenced by world conditions and over the past few years manufacturers of concentrated compound fertilisers in some countries, mainly in Europe, have increased their production more than enough to cover the increased consumption in their own areas. Consequently, export markets for the excess production have been sought in countries where fertilisers are in demand — such as Malaya.

Most manufacturers have a similar approach in that they begin by offering the range of formulations already being manufactured for their own conditions. When these are examined several important differences between the compound fertilisers meant for temperate crops and soils and the locally mixed product are usually apparent and are briefly summarised as follows:

1. The percentage potash is much higher than normally used for rubber — which is a crop with an unusually low potash requirement. The content of K_2O is usually 12% or more, whereas the highest level in the R.R.I.M. mixtures is 8.4%.
2. The phosphate is usually water soluble — in contrast with the water insoluble rock phosphate in R.R.I.M. mixtures. The degree of solubility seems to have little importance for rubber grown on acid soils and under a high rainfall, whereas water soluble phosphate is more efficient for most temperate crops and soils. This question has been fully discussed in *Planters' Bulletin 41*, March 1959 (page 34), and reasons are given why rock phosphate and water soluble phosphates are equivalent in value on Malayan soils.

3. The compound fertilisers do not usually contain magnesium, this element being comparatively unimportant for most temperate climate crops. In Malaya, however, magnesium deficiency is widespread in rubber areas and a large proportion of the local mixtures sold for use on rubber contain magnesium.

Obviously, most of these differences can be overcome by manufacturing special formulations for use on Malayan rubber plantations with the correct proportions of N, P_2O_5, K_2O, and MgO and, where the volume of trade has grown to a certain level, this is being done. There have been cases, however, of unsuitable compounds being placed on the market and one of the main objects of this article is to help the grower appreciate the advantages and disadvantages of the different types of fertiliser.

COMPARING THE COSTS OF DIFFERENT FERTILISERS

Suitably formulated compound and mixed fertilisers both have their advantages and disadvantages for use in rubber cultivation, but these are normally less important considerations than the price at which the fertilisers are offered. The Rubber Research Institute normally advises comparisons of different fertiliser materials solely on the unit price of the different plant foods — *providing the latter are in the correct proportion to each other.*

In order to show how this comparison is carried out, let us compare a hypothetical compound (say N 20 : P_2O_5 14 : K_2O 6 : MgO 4) at $300 per ton c.i.f. with a mixture made up of the standard ingredients.

Prices of these ingredients will be taken as:

Ammonium sulphate, 21% N	$185 per ton c.i.f.
Rock phosphate, 36% P_2O_5	$125 ,, ,, ,,
Muriate of potash, 60% K_2O	$220 ,, ,, ,,
Kieserite, 26% MgO	$150 ,, ,, ,,

Therefore, 1 ton of the 20 : 14 : 6 : 4 compound is equivalent, in respect of N, P_2O_5, K_2O and MgO content, to the following weights of the standard ingredients used in mixtures:

N	: $\frac{20}{21} = 0.952$ tons of ammonium sulphate worth	$\$ \frac{20}{21} \times 185 = \$176.19$
P_2O_5	: $\frac{14}{36} = 0.389$,, of rock phosphate worth	$\$ \frac{14}{36} \times 125 = \$48.61$
K_2O	: $\frac{6}{60} = 0.100$,, of muriate of potash worth	$\$ \frac{6}{60} \times 220 = \$22.00$
MgO	: $\frac{4}{26} = 0.154$,, of Kieserite worth	$\$ \frac{4}{26} \times 150 = \$23.08$
Total weight 1.595 tons		Total value = $269.88

The ingredients are thus worth a total of $269.88 and if made up into a normal mixture the cost of mixing, say $10.00 per ton, should

be added, making $279.88 in all. Thus at $300 for the compound, the difference in cost is small but slightly in favour of the mixture. (This result is found in most comparisons of fertilisers at present available).

Transport costs from the port or godown to the estate, from the estate to the field and the costs of spreading are all included in the total cost of manuring and these of course, depend on the weight of fertiliser used. From the above calculation it is clear that 1.595 tons of the mixed fertiliser is required to supply the same weight of plant foods, as 1 ton of this particular compound fertiliser. Consequently transport costs will be 60 per cent higher when the mixture is used and this will reduce the difference in cost between the two sources of plant foods, especially in remote districts.

PHYSICAL CHARACTERISTICS

The most obvious difference between mixed and compound fertilisers is in their appearance. The former are a loose mixture of amorphous and crystalline components (*Figure 1*) whereas the latter are granular (*Figure 2*), manufactured from a slurry of components which is then dried by a special process. All the granules are identical and each contains the stated proportions of plant foods. This granulation results in an easily handled product which is usually well packed in polythene or bitumen lined bags.

The simple process of mixing, if improperly carried out, can give a non-uniform product with consequent uneven application of the plant foods to the individual trees. It must be said, however, that on analysis, samples of mixed fertilisers from the major suppliers have always shown a composition close to that stipulated for the mixture concerned. Another possibility with mixed fertiliser is the separation of ingredients of different particle sizes on storage, but no cases of this have been found so far and these possibilities are perhaps no argument against the use of the mixtures.

The reason for the excellent packing of most compound fertilisers is quite clear when a bag is opened and left in a humid atmosphere for some time. Water is absorbed and the granules become soft, sticky and difficult to handle. Most mixed fertilisers however contain non-hygroscopic components and can

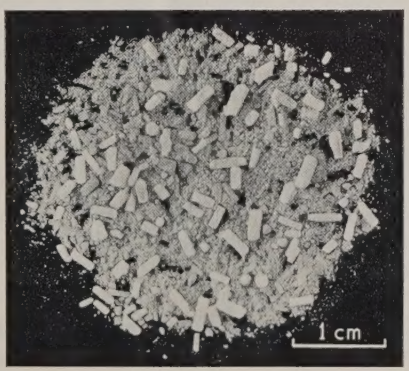

Figure 1. A typical mixed fertiliser. Crystals of ammonium sulphate can be clearly distinguished from the other finer components.

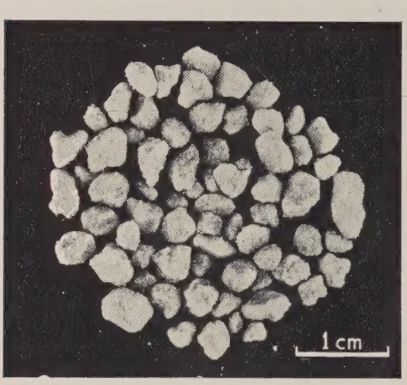

Figure 2. A granulated compound fertiliser (on the same scale as Figure 1).

be left open to the atmosphere without deterioration for some time. A related phenomenon due to the absorption of small amounts of moisture is 'caking' when the fertiliser becomes fused into large blocks and must be broken down before use. This sometimes occurs in both types of material, but is minimised in compound fertilisers by the granulation and moisture-proof packing and in the mixed fertilisers by inert components — particularly rock-phosphate — which are unaffected by atmospheric moisture. Most compound fertilisers therefore must be used immediately the bag is opened, whereas mixtures can be stored for some time in bags from which some of the material has been removed.

A question often asked by planters is whether or not granulated materials are more efficient than the normal mixtures in that they might release their plant foods over a longer period. This is not the case, the nutrients in most types of compound fertiliser being readily soluble. Any residue of the granules which may be seen some time after application is usually insoluble material containing none of the main ingredients. Experiments show that the physical form of the fertiliser is of minor importance in its effect on plant growth.

NEED FOR CAUTION WITH WATER SOLUBLE PHOSPHATE

Whilst rock phosphate and water soluble phosphate are equivalent in their effects on growth of rubber trees at the normal rates of application, this is not so when excess phosphate is applied. Excess water soluble phosphate can cause damage to very young rubber trees and several cases of damage due to the use of excessive amounts of compound fertilisers have been diagnosed recently — mainly in nurseries. Experiments in pots at the Rubber Research Institute have also shown that damage can occur at rates of application of water soluble phosphate which cause no difficulty with rock phosphate. Because of this possibility of damage, compound fertilisers are not recommended for use in the planting hole and growers are advised to use rates of application to young rubber equivalent to these set out in the standard schedule of manuring for R.R.I.M. mixtures.

SPECIAL MIXTURES

The simple process of mixing, usually carried out in small batches of a few tons, makes it easy to change the proportions of individual plant foods to suit any particular area of rubber and in fact some growers prefer to order what are usually called 'Special' mixtures. A typical example of this is the inclusion of small amounts of manganese sulphate for areas where a manganese deficiency has been found. The use of special mixtures can be expected to increase with refinements in the methods of determining deficiencies in individual areas — perhaps by means of leaf or soil analysis — and with increasing knowledge of the deficiencies occurring with individual clones or on particular soil types. Compound fertilisers are not so adaptable, the minimum quantity of one particular formulation being of the order of one thousand tons for economic manufacture; consequently only a limited range of formulations is normally available and any special requirement must be applied as a supplementary fertiliser application.

ACIDIFICATION OF THE SOIL

Another difference between concentrated compounds and mixed fertilisers lies in their effects on soil reaction.

The ammonium sulphate used in mixtures, chiefly because of the sulphate it contains, is more acidifying than the nitrogen components of compound fertilisers. The addition of extra sulphate to the soil is of little importance for tree growth on most soils and merely causes extra losses of such plant foods as calcium, magnesium and potassium when it leaches away in the drainage water. This process has been discussed recently in an article on 'Soil reaction and rubber cultivation' in *Planters' Bulletin 50,* September 1960, page 98. Losses of magnesium and potassium caused by excess sulphate are of some significance and must eventually be replaced from external sources.

On the other hand, mixtures containing rock phosphate add more calcium to the soil than concentrated compound fertilisers, but whether this is of much importance for tree growth is still unknown as no definite calcium deficiencies have been diagnosed in the field.

EXPERIMENTAL RESULTS

For the past two years, experiments have been carried out on immature rubber comparing compound fertilisers containing water soluble phosphate with equivalent fertiliser mixtures made up with the usual ingredients. So far, no differences whatsoever have been found in the growth of comparable plots. This seems to confirm the view that the two types of fertilisers are equivalent in value and that they should be compared principally on the total cost of application in the field.

CONCLUSION

This discussion of the advantages and disadvantages of mixed and compound fertilisers has, of necessity, been rather general and, as with

most generalisations, there are exceptions. Some compound fertilisers, for example, are no more concentrated than the normal mixtures and some mixed fertilisers contain hygroscopic components or water soluble phosphate. These exceptions are not of major importance and do not invalidate the comparison which we have made of the outstanding features of typical examples of the two types of fertiliser. Evidently there is a place for both types in the cultivation of rubber in Malaya. In some circumstances one can be more efficient or economical than the other and it is hoped that this article will help the grower to decide which would be the most suitable for his particular purpose. It should also help him to avoid the more unsuitable fertilisers occasionally offered.

Loss of Ammonia from Surface Applications of Urea Fertiliser

UREA IS A COMPOUND of nitrogen, hydrogen, carbon and oxygen having the formula NH_2CONH_2, and in the pure form contains 46.7% of nitrogen; it occurs naturally in animal urine, and the characteristic smell of ammonia in stables is due to its rapid decomposition in urine residues on the floor and walls with consequent evolution of ammonia gas. The high nitrogen content of urea (by comparison ammonium sulphate contains only 21% nitrogen) gives it considerable attraction as a nitrogenous fertiliser, and millions of tons per annum of the material are now produced synthetically in different countries, by causing ammonia and carbon dioxide to react together under pressure.

The high nitrogen content of urea leads to appreciable savings in costs of transport and application: for instance only one pound of urea is required to supply approximately the same weight of nitrogen as two pounds of ammonium sulphate. As pointed out in *Planters' Bulletin 50,* urea contains no acidic anion corresponding to the sulphate ion in sulphate of ammonia; consequently its acidifying effect in the soil, which is caused by nitrification of ammonium ions released from it, is about one third to one half that produced by sulphate of ammonia, when equivalent amounts of nitrogen are applied. On the other hand, sulphate of ammonia would possess an advantage over urea should sulphur deficiency occur in *Hevea.* A disadvantage of urea is its property of quickly absorbing moisture from the air, becoming moist and sticky in the process, but this difficulty can be partially overcome by pelleting the urea, coating the pellets with an inert material and packing them in polythene lined bags.

Urea has found its greatest application in rice cultivation where it can be worked into the soil, and attempts have been made to introduce it for use as a surface dressing in rubber cultivation. Unfortunately,

when applied to a moist soil surface, urea is quickly decomposed by an enzymatic reaction to ammonium carbonate—a chemical in which the ammonium and carbonate ions are only very weakly bound together and from which ammonia may volatilise into the atmosphere. A loss of ammonia by such volatilisation has been observed by a number of research workers and has been confirmed in recent investigations at the Institute. Full details of the work will be published as an article entitled 'Loss of ammonia from surface application of urea in rubber cultivation', in the *Journal of the Rubber Research Institute of Malaya;* a summary of the conclusions is given below.

EXPERIMENTAL RESULTS

Tests were carried out to measure the evolution of ammonia from urea applied to bare soil, to leaf litter in mature rubber and to covers of leguminous creepers and other plants in young rubber. In applications to soil the ammonium ion released from decomposing urea can be adsorbed by the soil exchange complex and so less ammonia would be expected to volatilise from soils having a high exchange capacity, such as the clay soils, than from soils having a low exchange capacity such as the loams and sandy loams. This has been found true, little ammonia being lost from urea applied to the bare surface of clay soils such as those of the Selangor series. Decomposition does not occur under dry conditions and the loss from urea applied to the bare surface of loams and sandy loam soils when very dry was also small, but losses of up to 24% of the applied nitrogen were recorded from urea applied to the surface of loams and sandy loam soils when these were just sufficiently moist for the enzymatic reaction to take place. In applications of urea to soil *saturated* with moisture, however, losses of only 10% were recorded, and it seems that urea can diffuse through moist soil with ammonia loss decreasing with increase in the soil moisture.

When applied to covers of leguminous creepers in immature rubber, losses of from 10 to 28% of the applied nitrogen were recorded over a period of six days, with maximum losses taking place under moist shaded conditions. Losses of from 10 to 18% were recorded from urea applied to the rubber leaf litter found under mature rubber, regardless of soil type.

A comparison of the volatilisation of ammonia from urea with that from a 1: 1 mixture of urea and rock phosphate, when applied to bare, moist soil, showed similar losses to occur from both materials.

COSTS

Although urea has certain intrinsic advantages over ammonium sulphate, the decision on whether to use it in rubber cultivation must depend mainly upon whether or not the losses of ammonia by surface volatilisation outweigh the savings in transport costs resulting from the high concentration of nitrogen in this fertiliser. Examples have been

COMPARATIVE COSTS OF UREA AND AMMONIUM SULPHATE

Fertiliser	*% nitrogen*	*Cost per ton f.o.l. 12.7.61*	*Amount required to supply 1 ton of nitrogen (tons)*	*Cost per ton of nitrogen*	*Total cost per ton N including transport charges at*	
					$6/ton fertiliser	*$18/ton fertiliser*
Urea	45	$350	2.22	$777	$790	$817
Ammonium sulphate	21	$185	4.76	$881	$910	$967
Cost difference, in favour of urea				$104	$120	$150
Percentage savings when using urea instead of ammonium sulphate				11.8	13.2	15.5

calculated in the *Table* to show the savings obtained by the use of urea instead of ammonium sulphate, at the current list prices.

It is evident that, at the quoted prices, losses of up to at least 10% of the applied ammonia can be accepted, particularly where transport costs are high, before the urea will begin to lose its cost advantage over ammonium sulphate.

RECOMMENDATIONS

General experience together with the experimental results and cost figures quoted above enable the following recommendations to be made as to the conditions under which urea may or may not be used.

1. *Conditions Under Which Urea May Be Safely Used*

   a. Where the fertiliser is to be forked into the upper soil layers, urea may be applied safely to bare soil of any type (excepting alkaline limestone-derived soils) under all moisture conditions. Evolved ammonia will be fixed by the soil exchange complex and little, if any, loss by surface volatilisation will take place.

   b. Urea may be safely broadcast on bare heavy clay soils, such as those of the coastal alluvial type, under all moisture conditions. Even under the most favourable conditions for decomposition, losses of ammonia on such soil types will be below the critical 10% mentioned above, owing to rapid adsorption of evolved ammonia by the clay.

2. *Conditions Involving a Degree of Risk*

   Urea may be broadcast (but with some risk of subsequent ammonia losses under certain weather conditions) on loam and sandy loam soils, and on cover plants and rubber leaf litter, when these are very dry, i.e. under hot, sunny weather conditions; no decomposition will take place and the urea will remain unchanged

until the soil or plant material becomes moist. If heavy rain falls the urea will be washed into the soil and there will be little loss, but if only light rain falls the urea may remain at the moist soil surface, with the result that decomposition will take place and some ammonia loss will be likely.

3. *Conditions Under Which Urea May Not Be Safely Used*

Urea should not be broadcast on moist soils of the loam and sandy loam types, or on covers and rubber leaf litter, that are drying after rain — particularly under shaded conditions. Under these conditions the urea will actively decompose on the soil, plant or litter surface, and, since adsorption by these surfaces is low, major losses of ammonia may be expected to occur during the four to five days after application unless heavy rain washes the fertiliser into the soil.

Given the favourable conditions described above (1 a and 1 b), urea will be a more economical nitrogenous fertiliser to use than ammonium sulphate. This will apply to all types of urea likely to be sold on the Malayan market and to mixtures of urea with rock phosphate and muriate of potash in mixed fertilisers. The conditions outlined under (2) can at present best be described as 'marginal' or 'doubtful', in that the use of urea in these circumstances will be economic only if the rainfall which follows is heavy. Further experiments and practical experience may throw more light on the nature of the risk involved.

Cover Plants, Manuring and Wind Damage

A QUESTION ASKED BY MANY PLANTERS is to what extent wind damage in young replantings can be minimised by decreasing or omitting fertiliser dressings. Our recommendations on this subject have so far been restricted to suggestions that fertiliser dressings should be small and frequent rather than heavy and infrequent (*Planters' Bulletin 43*, July 1959, p. 92) and that nitrogen applications may be reduced after trees reach tappable size (*Planters' Bulletin 55*, July 1961, p. 99). Both recommendations are based on the observation that heavy manuring, particularly with nitrogenous fertilisers, will stimulate the development of a heavy leaf canopy that may accentuate the stem bending shown during immaturity by clones such as LCB 1320, RRIM 603 and RRIM 526, and perhaps trunk snap during the early years of tapping, as in the case of RRIM 501.

Experimental results are now helping us to formulate a more definite policy with regard to manuring in immature plantings, where stem bending is the main problem, and papers published in the *Proceedings*

of the Natural Rubber Research Conference, 1960, provide the first indication of the trend that recommendations should take. The paper on 'Manuring of Rubber in Relation to Wind Damage' quotes results demonstrating that high levels of nitrogen application in mature rubber can increase the incidence of wind damage, probably because of the increased size of canopy and consequent susceptibility to wind damage. The paper on 'Cover Plants and the Soil Nutrient Cycle in *Hevea* Cultivation', gives results describing the very large quantities of nitrogen that are built up in covers of leguminous creepers and states that the nitrogen and phosphorus contents of the trees, and the rate of tree growth, are all increased by the use of leguminous creeping covers in comparison with non-leguminous covers.

A third paper 'Effect of Ground Cover Type and Continuity of Nitrogenous Fertiliser Treatment upon the Growth to Tappable Maturity of *Hevea brasiliensis*', confirms the results of the previous paper and is of particular interest in that it quotes results showing that, in an immature planting with leguminous creeping covers, the cessation of nitrogen fertilising at twenty-four months after budding did not appreciably retard the rate of tree growth when compared with continued nitrogen application up to tapping. This last paper goes so far as to suggest that where a good leguminous cover has been established, and when the application of too high a level of nitrogen may lead to excessive development of the crown, the application of nitrogen fertilisers can be reduced, or for a time omitted, without jeopardising the future development of the rubber.

The above investigations, and others, emphasise the way in which nitrogen applications may lead to an increase in susceptibility to wind damage. None of our work has so far supported the suggestion that a low potash level in the tree may be related to wind damage susceptibility.

RETURN OF NUTRIENTS TO THE SOIL BY DETERIORATING LEGUME COVERS

Since the Research Conference, more sampling has been carried out in the cover plant experiments run by the Institute, and the results obtained confirm that very large quantities of nutrients are mobilised by covers of leguminous creepers. In *Table 1* results are quoted from three successive annual samplings of cover plants in the oldest experiment (No. 23), now four and a half years from planting. It can be seen that between the first and the second sampling there was a net build-up of dry matter and nutrient content in the leguminous covers, but that between the samplings at 34 months and 47 months after planting, as the covers began to deteriorate owing to shading, there was a large net decrease in the quantity of nutrients held in the cover.

The net decrease in nitrogen was equivalent to the return of 540 lb per acre of ammonium sulphate to the soil, even when allowing for

TABLE 1. EXPERIMENT 23, VARIATION WITH TIME IN THE NUTRIENT CONTENT OF LEGUMINOUS CREEPING COVERS. LB PER ACRE

Time of sampling (months after planting)	*Total dry weight (Green material and dead litter)*	*Total nitrogen*	*Total phosphorus*	*Total potassium*	*Total calcium*	*Total magnesium*
20	9,125	245	21	54	166	19
34	11,502	320	28	73	279	27
47	6,471	176	15	38	154	12
Net decrease between 34 and 47 months	5,031	144	13	35	125	15
Net decrease between 34 and 47 months expressed as fertiliser equivalent returned to the soil*		540 ammonium sulphate	62 rock phosphate	53 muriate of potash	234 limestone	72 Kieserite

* allowing for 25% of the area being clean-weeded.

25% of the area being clean-weeded: equivalent to a dressing of 3.6 lb per tree with a stand of 150 trees per acre. All of this high return of nitrogen may not be in a form that is as quickly available for tree uptake as is the nitrogen in ammonium sulphate. Soil analysis, however, has detected consistently higher levels of nitrate nitrogen under covers of leguminous creepers than under non-leguminous creepers and the rate of mineralisation of the organic nitrogen appears to be high.

Other figures quoted in *Table 1* show that phosphate equivalent to 62 lb per acre of rock phosphate was returned to the soil between the 34th and the 47th month. This is quite a large figure, and since it is quite possible that this phosphate will be in a form that is easily available, it should have an appreciable effect on uptake of phosphorus by the tree, as has in fact been confirmed by analysis of tree leaves.

The above results do not take into account the nutrient content of the cover plant roots. This is likely to be high and will also become available for uptake by tree roots as the cover plants die out, so that the figures quoted may be taken as a conservative estimate of the total release of nutrients to the soil. From all these facts it seems quite evident that major quantities of nutrients are released from leguminous covers as they die out, and that a reduction, at least in nitrogenous fertiliser applications, could be introduced at the third or fourth year after planting

VARIATIONS IN NUTRIENT CONTENT OF LEGUME COVERS

Results from four other experiments in which the covers received similar treatment and in which only two samplings have been carried out so far, confirm the build-up of nutrients as shown in the first and second samplings of Experiment 23, so that the above results are likely to be fairly typical for areas where vigorous legume covers are maintained. At the same time other work has shown that it is possible for the nutrient content of leguminous creeping covers to vary appreciably from site to site depending on soil type and cultivation history, and this needs to be borne in mind when suggesting alterations to fertiliser programmes.

In *Table 2,* results are quoted from a phosphate manuring experiment on leguminous creeping covers in which the following fertiliser applications were made:

Months after planting	*Rock phosphate (cwt per acre)*		
	p_0	p_1	p_2
0 — 12	0	2½	5
12 — 24	0	1	2
24 — 36	0	1	2

The experiment was carried out on a shale-derived loamy soil that was rather low in phosphate content, and it can be seen that the application of phosphatic fertilisers has led to a marked variation in the nitrogen

TABLE 2. EFFECT OF PHOSPHATIC MANURING ON THE NUTRIENT CONTENT OF LEGUMINOUS CREEPING COVERS. LB PER ACRE

Treatment	*Total dry weight (Green material and dead litter)*			*Total nitrogen*			*Total phosphorus*		
	p_0	p_1	p_2	p_0	p_1	p_2	p_0	p_1	p_2
Time of sampling (months after planting)									
24	9,210	11,171	11,630	197	271	295	8.3	15.9	25.5
36	7,798	8,102	7,371	186	193	184	8.3	12.2	14.9
Net decrease between 24 and 36 months	1,412	3,069	4,259	11	78	111	0	3.7	10.6
Net decrease between 24 and 36 months expressed as fertiliser equivalent returned to the soil.				55 ammonium	390 sulphate	555	0	23.5 rock	67.4 phosphate

and phosphorus content of the covers. This has had a large effect on the amount of nutrients returned to the soil between the 24th and 36th month after planting (this experiment was carried out in a seedling area whilst Experiment 23 was in a budded area, so that in the former the leguminous covers began to deteriorate rather sooner because of the earlier shading).

The difference in the amount of nitrogen returned to the soil by the p_0 and p_2 treatments was equivalent to 500 lb per acre of ammonium sulphate whilst the return of phosphorus was equivalent to 67.4 lb per acre of rock phosphate. From these results it is apparent that on the poorer soils there could be large differences in the amount of nutrients mobilised by a legume cover which had received a generous dressing of rock phosphate and by a cover that had received only the bare minimum, and fertiliser policies would need to be adjusted accordingly. Incidentally it is important to know that there was no major visual difference in vigour between p_0 and p_1 covers in this experiment, so that the visual appearance of a cover can be deceptive.

RECOMMENDATIONS

Continued manuring. Under conditions of moderate or poor fertility, where legumes do not survive for long as a pure cover, normal fertiliser programmes similar to that quoted in *Planters' Bulletin 35* should be maintained without interruption.

Suspension of nitrogenous manuring. On the other hand where the soil is of average fertility, where the leguminous covers are vigorous and have received regular dressings of rock phosphate, and when the planting material is susceptible to wind damage with trees perhaps showing stem bending, we recommend that as the covers die out the addition of nitrogenous fertilisers should be suspended for two to three years. Rock phosphate, or on the sandier type of soils a suitable mixture of rock phosphate and muriate of potash, should continue to be added.

Suspension of all manuring. It seems probable that in the very best conditions, where tree growth is obviously vigorous with the trees developing heavy canopies, all applications of fertilisers could be halted for a period of two to three years, to be renewed as the mulch remaining from the leguminous cover disappears or as the trees appear to show signs of requiring further fertiliser applications.

Resumption of manuring. The data in *Table 1*, showing a decrease in cover plant dry matter of nearly 50% between the 34th and 47th month after planting indicates that little will be left after another two years. Further experimental work needs to be done on the persistence of these covers, and of the residual effect of the large return of nutrients to the soil, but it seems likely that the soil will remain at a high nutrient level for at least one year after disappearance of the covers and it may be necessary to resume normal fertilising only at the sixth

or seventh year after planting.

More data are required before firm recommendations can be made however, and the decision on when to resume normal fertiliser applications must depend on visual assessment in the field. For the present it would be wise to adopt a conservative policy and resume manuring in the third year after cessation of nitrogen applications, for it is imperative to maintain good girthing rates during the first years of tapping and a marked depression of growth rates might have adverse effects on the wind fastness of the trees, as suggested in *Planters' Bulletin 43*, July 1959.

Substitutes for Sodium Arsenite

THE INTRODUCTION of the ban on sodium arsenite, previously expected to take place in September 1961, has been deferred for six months from that date, but this postponement has not reduced the need for efficient and economical substitutes. Both the Rubber Research Institute of Malaya and commercial companies have already carried out trials with possible substitutes and this work is being prosecuted more intensively now than before, so that the use of sodium arsenite may be discontinued as soon as possible.

The forthcoming issues of *Planters' Bulletin* will contain articles describing important weeds encountered in rubber plantations, illustrated by line drawings and accompanied by ecological notes and recommendations for their control by chemical herbicides. It is hoped that in this way the planter will be kept up to date with developments.

For the present, our advisory recommendations for chemicals must remain as outlined in *Planters' Bulletin 44*, September 1959, since few effective herbicides have subsequently appeared on the market; some of the most notable recent developments will nevertheless be of interest to planters and are discussed in the following notes.

HERBICIDES TO BE SPRAYED ON ESTABLISHED VEGETATION

Aminotriazole

This chemical, mentioned as being promising in *Planters' Bulletin 44*, has proved of value against a number of weeds; 7.5 to 10 lb per acre of this herbicide* gives good control of *Paspalum conjugatum*, and may be used even when *Axonopus compressus* is present, but in the latter case preference may be given to a mixture composed of 5 lb of an aminotriazole formulation* and 5 lb of a dalapon formulation**.

For a mixed weed population, including broad-leaved weeds, a mixture of 25 lb of sodium chlorate and 5 lb of an aminotriazole formula-

* containing 50% of the active ingredient.
** containing 75% of the active ingredient.

tion* per acre is recommended. All these chemicals and mixtures may be applied as a liquid spray at a rate of 40 gallons per acre. Aminotriazole has also proved to be very effective against Straits rhododendron (*Melastoma malabathricum*).

Paraquat

Paraquat is a trade name for a complex organic chemical, which is showing considerable promise as a herbicide. Developed from chemicals used to kill off potato haulms, Paraquat has a very rapid defoliating effect and is effective against most of the commonly occurring weeds. It will probably not be available in commercial quantities until mid-1963 and is at present only obtainable for experimental purposes.

PRE-EMERGENCE HERBICIDES

Simazine

Simazine, when sprayed on bare soil, will destroy germinating weed seeds. Our work has shown that an application of this herbicide* to clean-weeded planting strips at the rate of 7½ lb per acre will inhibit the development of weed seeds for three to five months.

The best effects are obtained when the chemical is sprayed on to bare soil just before rain; the rain washes the Simazine into the upper soil layers where it will persist and exert its depressive effect upon weed seeds.

Some weeds, however, such as *Digitaria* spp. and sedges, are more or less resistant to Simazine, and if these are present it is recommended to spray first with dalapon or aminotriazole.

If the planting strips are bordered by creeping grasses or by a mixture of grasses and *Mikania scandens*, it is advisable to spray these weeds with 5 lb per acre of an aminotriazole formulation*, or if only *Mikania* is present, with 1 lb per acre of Fernoxone, in order to prevent invasion of the planting strips.

METHODS OF APPLYING HERBICIDES

It is felt that a considerable improvement could be made in the techniques of application used in Malaya. Spray equipment commonly used on rubber estates is comparatively crude and more attention should be paid to using the correct nozzle size and the most appropriate gallonage for the rate of application required.

A series of experiments has shown that in strip and blanket spraying of general weed populations, no advantage is gained by spraying at volumes in excess of 40 gallons per acre. At this level of application the normal type of spraying equipment will give good leaf coverage if the appropriate amount of wetting agent is added to the spray solution, without wasteful run-off. Even where the weed cover is dense, little advantage is gained by spraying more than 40 gallons per acre.

* containing 50% of the active ingredient.

To measure rates of application, a knowledge of the spray nozzle size and its rate of delivery in gallons per hour is required. Once these data are known it is easy to determine the area of soil to be covered with each tank-full of liquid.

In order to obtain information on methods of herbicide application used in the field, officers of the Estates' Advisory Service, when visiting estates, will be taking notes on the methods of spraying, type of spray equipment and herbicides used, together with other technical details. In this connection, we always welcome suggestions from estates and in particular would like to hear from estates where mechanical methods of spraying, the use of multiple charging-spraying batteries and other techniques have been adopted.

CONCLUSION

It is unlikely that any single substance will prove to be a satisfactory substitute for sodium arsenite. Indeed sodium arsenite itself is not fully effective against all weed combinations. Our current experiments aim at finding the most efficient combination of herbicides, not only to replace sodium arsenite, but also to provide improved weed control.

In developing our methods of weed control we must always bear in mind that the plants commonly termed weeds can often play a most useful role in checking soil erosion, and improving soil nutrient and moisture regimes. An open mind must be maintained upon the question of whether such plants should be eliminated or not.

Shipments of Boric Acid Latex

During the first six months of 1961, 532,958 imperial gallons of latex concentrate preserved with boric acid and low concentrations of ammonia were shipped from Malaya. This is a reduction of 13% on the quantity shipped during the same period in 1960, but the reduction is considerably less than the fall of 26% shown in total latex shipments in the first four months of 1961. The quantity of boric acid latex shipped amounts to 1356 long tons of dry rubber, representing about 3% of the total latex exported, and is probably equal in importance to any of the other established low ammonia latices.

Six companies produced boric acid low ammonia latex during the period, a decrease of two from the previous year. Over 90% of the total was made by one company, only one other showing an increase over the corresponding period in 1960. The output of the other four companies declined.

Boric acid latex was shipped to twelve consumer countries, namely Great Britain, Germany, South Africa, New Zealand, France, Japan, Sweden, Belgium, Ireland, Netherlands, Spain and Hong Kong. Shipments were made in bulk and also in drums and were distributed as follows:

Great Britain	48.6%
Rest of Europe	35.9%
Africa	12.0%
Far East and New Zealand	3.5%

Great Britain maintained her intake of boric acid latex at the same level as in 1960. European usage showed a considerable decrease especially in France, Belgium and Germany. South Africa jumped to third largest consumer with a considerably increased intake. New Zealand also showed an increase while interest has finally been stimulated in Japan. The absence of Australia and U.S.A. from the list of users is noteworthy in view of the compatibility of this latex with synthetic latices.

Boric acid latex has been established as a useful low ammonia latex for many manufacturing processes and is holding its own with other types of latex.

Patent Applications

Hydrazine Hydrate as Preservative and Mooney Stabiliser

British Patent Application No. 22236/61, by Messrs B.C. Sekhar and D.H. Taysum of the Chemical Division, describes the use of hydrazine or hydrazine hydrate as an anticoagulant and Mooney viscosity stabiliser for dry rubber. This chemical may also be employed as a preservative for field and concentrated latex and when used in this way its action is similar to that of ammonia.

Consumer evaluation tests are now under way and the results will be made available as reliable information is obtained.

Improvements in or Relating to the Reinforcement of Rubber

A British patent application (No. 30813/61) has been made by the Institute for a process of reinforcing *Hevea* latex. The reinforced latex prepared by this method produces foams of superior compression modulus and films of greater strength. The inventors are Mr B.C. Sekhar and Mr S.N. Angove.

R.R.I.M. Patents

The policy of the R. R. I. M. Board is to seek patent protection in respect of our inventions in order to secure free and unrestricted application of our work for the whole of the planting industry.

When applications for a patent have been made we take the opportunity to disclose our findings as quickly as possible to ensure rapid dissemination of our knowledge to the industry, at the same time continuing the work of evaluating the new developments for commercial application.

Having completed the evaluation, we grant permits to Malayan producers, without charge, to use these processes with two conditions:

1. That we are regularly advised of the extent to which the process is being operated.
2. That samples representative of the whole production are submitted to the Institute to permit quality control. The producer is informed of the results should he require them.

Journal

The *Journal of the Rubber Research Institute of Malaya*, Volume 17, Part 1, contains three papers which are summarised below:

V.M. Shorrocks. *Leaf Analysis as a Guide to the Nutrition of Hevea brasiliensis I. Sampling Technique with Mature Trees: Principles and Preliminary Observations on the Variations in*

Leaf Nutrient Composition with Position on the Tree. Communication 337.

During the last decade emphasis has been laid on the use of leaf analysis as a guide to the manuring of *Hevea*. The problems relating to the choice of a sampling technique are of prime importance in such use of leaf analysis. The present paper, which is the first in a series on leaf analysis as a guide to the nutrition of mature *Hevea*, deals with the principles involved in leaf sampling, and the results of preliminary observations on the variation in leaf nutrient composition with position on the tree are presented. Differences between the nutrient content of leaves exposed to full sunlight and leaves in the shade of the canopy, and also between shaded leaves collected from different heights were observed. Little variation was observed, however, in the nutrient content of leaves exposed to full sunlight collected from different positions over the outside of the canopy.

The results indicate that it is essential to employ a standard sampling technique and four such techniques, which will be investigated further, are discussed. Differences were found in the magnitude of the effects of fertilisers on the nutrient composition of leaves from different positions and the preliminary results are discussed.

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B.S. Rao. *Pollination of Hevea in Malaya.* Communication 338.

This paper points to insects as the principal agents bringing about pollination of *Hevea* in Malaya, as in the American tropics. Insects visiting male and female flowers were observed for three successive years on the R.R.I.M. Experiment Station, and their possible role as pollinators noted. Midges appear to be the most important, thrips coming next, in bringing about natural pollination.

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V. M. Shorrocks and G. A. Watson. *Manganese Deficiency in Hevea: the Effect of Soil Application of Manganese Sulphate on the Manganese Status of the Tree.* Communication 339.

The frequent observation of manganese deficiency in immature and mature rubber prompted investigations into determining the ways in which the manganese status of *Hevea* could be improved. Manganese deficiency of *Hevea* in Malaya is the result of an absolute deficiency of manganese in the soil; this situation is in contrast to the more usual cases of induced manganese deficiency, where the soil manganese is rendered unavailable for plant uptake because of high pH or organic matter levels.

Soil applications of manganese sulphate were effective in increasing the manganese status of the tree, as measured by the manganese content of leaves, latex, bark and bark scrap rubber. Different rates and frequencies of manganese sulphate were used and it was concluded that two broadcast applications of 4 ounces per tree was the minimum treatment required to improve the manganese status of mature trees affected by moderate to severe manganese deficiency. Two 4-ounce dressings applied with a twelve-month interval were more effective than one application of 8 ounces, and definite residual effects of the two applications were recorded two and a half years after the second application.

The manganese content of the latex did not rise sufficiently to cause concern, but that of the bark scrap rubber, which was not washed in water before analysis, rose well above the tolerance limit of 10 p.p.m. manganese. Under normal estate practice such bark scrap rubber would be soaked and washed during milling, and the manganese content would be effectively reduced.

Retirement of Mr C. G. Akhurst

We announce with regret the retirement on October 10th of Mr C.G. Akhurst, Deputy Director of the Rubber Research Institute of Malaya.

Mr Akhurst studied from 1924—27 at the Royal College of Science (part of the Imperial College of Science and Technology, London University) where he obtained his B.Sc. and A.R.C.S. After working for one year under the late Dr E. M. Crowther in the Chemistry Division at Rothamsted Experiment Station, he studied at the Imperial College of Tropical Agriculture, Trinidad, where he obtained his Associateship in 1930.

Mr Akhurst came to Malaya in 1930 to join the R.R.I.M. as Soils Chemist and was appointed Head of Soils Division in 1937. At that time he was associated with a soil survey and was responsible for the continuation or initiation of many experiments on the manuring of rubber in new plantings and replantings, the establishment of cover plants and the effect of covers on tree growth. Unfortunately the war interrupted several of these experiments. Nevertheless, the very important experiments on the effect of fertilisers on the yield and growth of *Hevea* were recontinued after the war and yielded results which have been reported in our *Journal*.

A member of the Federated Malay States Volunteer Force, Mr Akhurst was taken prisoner of war in 1942 and returned to his post as Head of Soils Division in 1946. New manurial and cover crop experiments were then set up and experiments on the use of herbicides became an important part of the Division's work.

Mr Akhurst was appointed Deputy Director in 1953 and has since served as Acting Director on many occasions. He has taken a leading part in the scientific and social affairs of Kuala Lumpur, having been President of the Malayan Scientific Association from 1953 to 1957 and President of the Selangor Club. Numerous friends and associates in Malaya, as well as members af the Institute, will wish Mr and Mrs Akhurst every good fortune on their retirement.

R. R. I. News

Mr R.S. Gale, B.Sc., A.C.G.I., A.M.I Chem.E., resigned from the service of the Institute at the end of his third tour of duty on 31 August 1961, after serving for a little over ten years. The ready advice which he gave as the senior chemical engineer will be greatly missed by his colleagues. The industry will remember Mr Gale for his work on the drying of rubber, which influenced the design of the oil-fired drying tunnel and of the R.R.I. smokehouse and may well lead to further improvements in drier design. We wish Mr Gale every success in his new career in England.

Mr Chai Hon Chee joined the staff of the Smallholders' Advisory Service as an Assistant Smallholders' Advisory Officer on 21 June 1961. He holds a Diploma of Agriculture of the College of Agriculture, Serdang.

He was formerly employed by the Institute as a Rubber Instructor, but in 1956 joined the Sarawak Government Service as a Rubber Development Officer.

Mr. Chai will be concerned initially with the many new planting schemes in progress or about to be established throughout the country. Later he will fill an outstation post.

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Dr James P. C. Wong, B. Sc., Dr. Sc. Nat., joined the staff of the Smallholders' Advisory Service as an Assistant Smallholders' Advisory Officer on 1 July 1961. He obtained his B.Sc. at Lingnan University, Canton, and his degree of Doctor of Science at the Martin Luther Universität, Halle, Germany. He was formerly in the Singapore Education Department where he was responsible for science in the curricula of Chinese Schools.

Dr Wong will be responsible for the planning and supervising of training courses conducted by the Smallholders' Advisory Service.

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Mr J.S. Soosai, B.Sc., who is a graduate of Madras University, joined the Publications and Information Section as Librarian on 1 September 1961. Mr Soosai was appointed Librarian-designate in 1959. During the last two years he has been studying librarianship at the North Western Polytechnic, London, where he has successfully completed his qualifying examination for the Associateship of the Library Association. His main concern will be the improvement and extension of the library service to Research Officers.

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Mr Low Choong San joined the staff of the Botanical Division, as Research Officer Division B, on 2 October 1961. He was trained at the College of Agriculture, Serdang, Malaya, where he obtained the Diploma in Agriculture in 1954. He was later employed as Cadet Agricultural Assistant in the Department of Agriculture, Federation of Malaya. In 1956 Mr Low went to Cornell University, New York, U.S.A. where he obtained his B.Sc. degree in February 1960. After a year of research in Plant Physiology at Cornell University, he returned to Malaya.

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Dr R.L. Wastie joined the staff of the Pathological Division as Pathologist (Research Officer Division A) on 9 October 1961, filling the vacancy arising from the transfer of Mr Hutchison to the Estates' Advisory Service. Dr Wastie took a first class honours degree in Botany at Oxford University and subsequently did post-graduate research at the School of Botany, Cambridge, leading to the award of a Ph.D. degree. At Oxford, Dr Wastie's tutor was Dr J.L. Harley, an authority on mycorrhiza, and at Cambridge he worked under Dr S.D. Garrett, who has made a life study of root disease. Dr Wastie has joined the team working on root-infecting fungi, and will be extending the study of certain little-known fungi that are believed to be of practical significance.

Index 1960 and 1961

Titles of articles and important notes appear in italics. Titles of and references to the various sections of the Natural Rubber Research Conference, Kuala Lumpur, 1960, abstracted in *Planters' Bulletin 52* are followed by '(N.R.R.C.)'. The individual abstracts are not indexed.

Ackhurst, C.G., retirement 194 (1961)
Acidity, correction of in soil 102 (1960)
A Crown Budding Experiment 84 (1960)
Advisory services:
  estates 1 (1960)
  chemical 89 (1961)
Adzuki bean 122 (1960)
Amendments to Planting Recommendations 1959-60 13 (1960)
Aminotriazole 112, 160, 189 (1961)
Ammonia loss from surface applications of urea fertilisers 180 (1961)
Ammonium nitrate 100 (1960)
Ammonium sulphate 100 (1960); 176, 181 (1961)
An Experiment with Magnesium Limestone 103 (1960)
Arlett, C.F. 110 (1960)
Australian Import Duty 108 (1960)
Axonopus compressus 36 (1960); 189 (1961)

Bamboo eradication 112 (1961)
Bamboo rat, damage 19 (1960)
Bark:
  damage on pruned trees 94 (1961)
  reaction to yield stimulants 118 (1960)
  renewal, RRIM 600 series 10 (1960)
  scraping prior to yield stimulant application 99 (1961)
  temperatures of pruned (RRIM 501) trees 96 (1961)
  thickness, RRIM 619-630 10 (1960)
Basic slag 98 (1960)
Beaver damage 19 (1960)
Biochemistry of Latex I, II (N.R.R.C.) 35, 36 (1961)
Biogenesis of rubber (N.R.R.C.) 4 (1961)
Bird's eye spot 7 (1960)
Book Reviews:
  Elsevier's Rubber Dictionary 110 (1960)
  Fertilizer Use: Nutrition and Manuring of Tropical Crops by A. Jacob and H. van Uexkull 68 (1960)
  Johnson's Complete Rubber Manual 69 (1961)
  Manual of Rubber Planting (Malaya) by A.T. Edgar 126 (1960)
Borates and vulcanisation of latex compounds 18 (1960)
Boric acid and other low ammonia latices 16 (1960)
Boric Acid Latex 25 (1960)

Boric acid latex:
exports 108 (1960); 66 (1961)
patent 107 (1960)
shipments 191 (1961)
Boric Acid Latex Exports, 1960 66 (1961)
Breeding and Selection: Vegetative Propagation I, II (N.R.R.C.) 19, 21 (1961)
Brown bast:
buddings and clonal seedlings 134 (1961)
clonal seedlings 138 (1961)
RRIM 600 series 10 (1960)
RRIM 619-630 13 (1960)
Brown crepe, SP 26 (1960)
Brown discolouration in pale crepe production 83 (1960)

Calopogonium mucunoides 36 (1960)
Calcium 185 (1961)
Carbon/nitrogen ratio, value 38 (1960)
Centrosema pubescens 36, 106 (1960)
Chai Hon Chee 195 (1961)
Chamek creeper 16 (1960)
Chapman, J.H. 70 (1960)
Chemical advisory service 89 (1961)
Chemistry and Technology of Dry Rubber I, II (N.R.R.C.) 28, 29 (1961)
Chemistry and Technology of Latex I, II (N.R.R.C.) 32, 34 (1961)
Chin Peng Sung 114 (1961)
Cladosporium herbarum 7 (1960)
Classification (planting materials) method 47 (1961)
Clay fraction in the soil and pH 98 (1960)
Clay, Sir Geoffrey, K.C.M.G., O.B.E., M.C. 104 (1961)
Clearing old rubber 39 (1960)
Clitoria Rubiginosa 14 (1960)
Clitoria rubiginosa, seed treatment 95 (1960)
Clitoria rubiginosa, supply of 67 (1960)
Clonal resistance to root disease 44 (1960)
Clonal seed 143, 144 (1961)
Clonal seedlings:
use in Malaya 72 (1960); 54 (1961)
PBFP 48, 122 (1961)
PBIG 48, 49, 119, 122, 123, 127, 134 (1961)
PBIGG 49, 54, 55, 123, 125, 129, 135 (1961)
Tjir 1 75 (1960); 54, 55 (1961)
Clone identification 109 (1960)

Clones:
acreages of clones and clonal seedlings established on estates in Malaya 74 (1960); 54 (1961)
classification (girth and girth increment) 53 (1960)
use in Malaya 72 (1960); 54 (1961)
AVROS 427 50 (1961)
AVROS 1191 50 (1961)
AVROS 1447 50 (1961)
AVROS 1734 50, 53 (1961)
AVROS 2037 50 (1961)
BD 5 84, 85, 86 (1960)
Chemara 57 (1961)
Ch 26 49, 52, 140 (1961)
Ch 30 50, 52 (1961)
Ch 32 50, 53 (1961)
Ch 148 50 (1961)
Ch 153 50 (1961)
Gl 1 49, 50, 151 (1961)
GT 1 49, 51, 57, 174 (1961)
IRCI 6 50 (1961)
IRCI 7 49, 50 (1961)
LCB 870 84, 85, 86 (1960)
LCB 1320 59 (1960); 49, 56, 57, 163, 183 (1961)
Nab 12 50 (1961)
Nab 15 49, 53 (1961)
Nab 20 50 (1961)
Prang Besar 57 (1961)
PB 86 59 (1960); 50, 56, 119, 143, 144, 151 (1961)
PB 206 50 (1961)
PB 213 50 (1961)
PB 217 50 (1961)
PB 5/51 49, 51, 57 (1961)
PB 5/63 49, 51, 57, 136 (1961)
PB 5/76 50, 53 (1961)
PB 28/59 50, 53 (1961)
PB 28/83 50, 53 (1961)
PB T/157 49 (1961)
PB T/497 49 (1961)
PR 107 59 (1960); 49, 50, 56, 140, 143, 144 (1961)
PR 228 50 (1961)
PR 251 50 (1961)
PR 252 50 (1961)
RRIC 5 50 (1961)
RRIC 7 50 (1961)
RRIC 14 50 (1961)
RRIC 45 50 (1961)

RRIM 500 series 20 (1960)
RRIM 501 13, 20, 50 (1960); 48, 56, 59, 87, 91, 141, 143, 144, 163, 165, 174, 183 (1961)
RRIM 513 13 (1960); 49, 51, 57 (1961)
RRIM 519 49, 51 (1961)
RRIM 526 59 (1960); 49, 51, 183 (1961)
RRIM 527 59 (1960)
RRIM 600 series 8, 49, 67 (1960); 58 (1961)
RRIM 600 55 (1960); 50, 52, 59 (1961)
RRIM 603 55 (1960); 57, 59, 163, 165, 183 (1961)
RRIM 605 14, 55 (1960); 49, 52, 57, 59 (1961)
RRIM 606 14, 56 (1960); 59 (1961)
RRIM 607 14, 56 (1960); 50, 52, 59 (1961)
RRIM 609 56 (1960); 49, 52, 59 (1961)
RRIM 610 57 (1960)
RRIM 614 57 (1960); 59, 163 (1961)
RRIM 621 58 (1960); 61 (1961)
RRIM 623 14, 58 (1960); 50, 52, 57, 61 (1961)
RRIM 628 14, 58 (1960); 50, 52, 61 (1961)
RRIM 632 50 (1961)
RRIM 638 50 (1961)
RRIM 701 50, 53 (1961)
RRIM 707 50, 53 (1961)
Tjir 1 84, 85 (1960); 117, 125, 143, 144 (1961)
Tjir 1, elongated leaves 114 (1961)
WR 101 49, 53 (1961)
Cockchafers 122 (1960); 68 (1961)
Conference:
International Rubber 1960 70 (1960)
Natural Rubber Research 1960 47, 107, 111 (1960)
Conference, Natural Rubber Research, 1960, summaries of proceedings 1 (1961)
Conference of Rubber Research Institutes of the Far East 48 (1960)
Conference: Rubber technology 47 (1960)
Cook, A.S. 87 (1960)
Co-ordinating Advisory Committee of the Malayan Rubber Fund Board 109 (1961)
Correction of Manganese Deficiency 63 (1961)
Correspondence: Girth Increment of Clone RRIM 501 on Alternate Daily Periodic Tapping 87 (1961)
Costs:
ammonium sulphate 182 (1961)
fertilisers, comparison of various 176 (1961)
tapping 139, 146 (1961)
upkeep of cover plants 161 (1961)

upkeep of immature rubber 133 (1961)
urea fertiliser 181, 182 (1961)
Cover plants (*see also* under names of species):
analysis 37 (1960)
and weed control (N.R.R.C.) 15, 17 (1961)
Centrosema pubescens 162 (1961)
Clitoria rubiginosa 14 (1960)
cost of upkeep 161 (1961)
effect on *Hevea* 35 (1960)
grass 160 (1961)
influence on wind damage 162, 163, 173, 183 (1961)
leguminous creepers 14, 35, 67, 98, 119 (1960); 76, 160 (1961)
Mikania scandens 35, 36 (1960); 160, 162, 190 (1961)
Nephrolepsis sp. 161 (1960)
nitrogen content 35 (1960)
nutrients returned to soil by leguminous covers 184 (1961)
Pueraria phaseoloides 36, 106 (1960); 162 (1961)
RRIM experiments 35 (1960)
seed treatment and sowing methods 94 (1960)
Cover Plants, Manuring and Wind Damage 163, 183 (1961)
Creepers, leguminous *see* Cover plants
Crown budding 84 (1960)
Crepe:
brown, SP 26 (1960); 81, 82, 83 (1961)
pale 80 (1960)
SP 81, 82, 83 (1961)
Cuscuta Australis, a Parasite of Cover Plants 86 (1960)

Dalapon 112, 189 (1961)
Damage by a Bamboo Rat 19 (1960)
Davidson, L.R., retirement 130 (1960)
Defoliation, 2,4,5-T application 41 (1960)
Demonstration of root disease control 7 (1960)
Depth of Bark Scraping Before the Application of Yield Stimulants 99 (1961)
Digitaria spp. 190 (1961)
Disease, clonal susceptibility 54 (1960)
Diseased trees, treatment 75 (1961)
Dodder, *Cuscuta australis*, a parasite 86 (1960)
Dothidella ulei 3, 7 (1960)
Drying of rubber, recent developments 65 (1960)
Drying rates of sheet rubber, apparatus for the study of 105 (1960)
Drying time, PA 80 coagulum 28 (1960)
Dry rubber content, RRIM 600 series 10 (1960)
Dry rubber content, RRIM 619-630 13 (1960)

Ecology, Environment: Ground Covers, Weed Control I, II (N.R.R.C.) 15, 17 (1961)
Edgar, A.T., *Manual of Rubber Planting (Malaya)* 1958 126 (1960)
Editorials:
An Outstanding Success 111 (1960)
Chemical Advisory Service 89 (1961)
Malayan Rubber Production 1960-1970 43 (1961)
Planters' Conference 71 (1961)
Planters' Conference 1961 115 (1961)
Progress 23 (1960)
Replanting on Small Estates 91 (1960)
Technical Service to the Malayan Rubber Manufacturer 71 (1960)
The Estates Advisory Service 1 (1960)
The Natural Rubber Research Conference (1960) 47 (1960)
Wind Damage 173 (1961)
EDTA (Ethylenediamine tetracetic acid) 16 (1960)
Elastomer synthesis, new methods of and their impact on natural rubber (N.R.R.C.) 5 (1961)
Elongated Leaves 113 (1961)
Emulsion A concentrate, effect on field latex 82 (1960)
Eradicants *see* Herbicides
Eradication of Bamboo 112 (1961)
Estates Advisory Service 1 (1960)
Estates, ownership 76 (1960)
Estates, small, replanting progress 91 (1960)

Factory Practice and Allied Subjects (N.R.R.C.) 38 (1961)
Fasciation. A Harmless Deformity of Rubber 84 (1961)
Fernoxone 162 (1961)
Fertilisers:
acidification of soils 178 (1961)
ammonium nitrate 100 (1960)
ammonium sulphate 38, 100 (1960); 142, 176, 182, 185 (1961)
basic slag 98 (1960)
costs 176, 178 (1961)
influence on wind damage 166, 173, 183 (1961)
Kieserite (sulphate of magnesium) 176, 185 (1961)
limestone 104 (1960); 185 (1961)
magnesium 163, 176 (1961)
magnesium limestone 104 (1960)
magnesium sulphate 100 (1960)
manganese mixtures, composition 65 (1961)
manganese sulphate 64, 193 (1961)
mixed and compound 175 (1961)
Nitrogen (*see also* ammonium nitrate and sulphate) 38 (1960); 163, 167 (1961)

phosphate *see* rock phosphate and superphosphate
phosphorus 163 (1961)
potassium 100 (1960); 163, 167, 175, 185 (1961)
rock phosphate 100, 106 (1960); 175, 181, 185 (1961)
R.R.I.M. formulae 175 (1961)
R.R.I.M. mixtures M, C_2, X, Y 175 (1961)
sodium nitrate 100 (1960)
special mixtures 179 (1961)
superphosphate 100, 106 (1960)
urea 100 (1960); 180 (1961)
water soluble phosphates 175 (1961)
Fertilisers, effect on soil reaction 100 (1960)
Fertiliser requirements:
experiments in Malaya 113 (1960)
'physiological diagnosis' in Vietnam 112 (1960)
recent developments 112 (1960)
Flemingia congesta 76 (1961)
Flomore 115 (1960); 103, 142 (1961)
Foliage identification of root disease 168 (1961)
Fomes lignosus 72, 74, 75, 168, 169, 170 (1961)
Fomes noxius 72, 75 (1961)
Fungi:
Fomes lignosus 72 (1961); 168 (1961)
Fomes noxius 72 (1961)
Ganoderma pseudoferreum 72 (1961); 170 (1961)
Fungicide:
Tillex 168 (1961)

Gale, R.S. 105 (1960); 194 (1961)
Ganoderma pseudoferreum 72, 73, 75, 170 (1961)
General Sessions (N.R.R.C.) 4 (1961)
Germination and seed treatment for cover crops 95 (1960)
Gigantochloa levis 112 (1961)
Girth:
at opening 140, 146, 149, 174 (1961)
effect of resting 153, 158 (1961)
increment of RRIM 501 on alternate daily periodic tapping 87 (1961)
increment of tapped and untapped trees 152 (1961)
of pollarded, pruned and control RRIM 501 94, 97 (1961)
RRIM 600 series 50 (1960)
RRIM 600-618 8 (1960)
RRIM 619-630 10 (1960)
Gloeosporium alborubrum 3, 7 (1960)
Gomez, J.B. 42 (1961)

Grasses:
Axonopus compressus 162 (1961)
Imperata cylindrica (lalang) 161 (1961)
Ischaemum muticum 162 (1961)
Paspalum conjugatum 162, 189 (1961)
Growth (*see also* Girth) and magnesium limestone 104 (1960)

Heat Scorch by Pebbles 125 (1960)
Hemitarsonemus latus 3, 6 (1960)
Heptachlor 68 (1961)
Herbicides:
aminotriazole 112, 160, 189 (1961)
application methods 190 (1961)
dalapon 112, 189 (1961)
Fernoxone 162 (1961)
Lallicide 112 (1961)
Paraquat 160, 190 (1961)
pre-emergence 160, 190 (1961)
Simazine 160, 190 (1961)
sodium arsenite 112, 160, 189 (1961)
sodium chlorate 112, 160, 189 (1961)
2,4,5-T 113 (1961)
High yielding material, use of 25, 93 (1960)
Holotrichia bidentata 123 (1960)
Hsia, R.C.H. 70 (1960)
Hydrazine hydrate as preservative and Mooney stabiliser 192 (1961)

Imperata cylindrica (lalang) 161 (1961)
Indigenous cover; nitrogen accumulation 39 (1960)
Influence of Field Latex on Latex Concentrate Quality 60 (1960)
Insecticide: Heptachlor 68 (1961)
International rubber conferences 47 (1960)
International Rubber Conference in West Berlin, 1960 70 (1960)
International Rubber Study Group 49 (1960)
Iron and chlorosis in leaves in *Hevea* 103 (1960)

Journal of the Rubber Research Institute of Malaya, reviews of articles:
Volume 16, Part 1 20 (1960)
Volume 16, Part 2 87 (1960)
Volume 16, Part 3 105 (1960)
Volume 16, Part 4 67 (1961)
Volume 17, Part 1 193 (1961)

Kachang sepalit 119 (1960
Kaimal, K.N., Obituary 130 (1960)

Kieserite (sulphate of magnesium) 176, 185 (1961)
KOH number 17, 18 (1960)

Lalang (*Imperata cylindrica*) 161 (1961)
Lallicide 112 (1961)
Large scale variety trials of *Hevea brasiliensis* on Malayan Estates 20 (1960)
Late dripping 13 (1960); 59, 157 (1961)
Latex:
biochemistry (N.R.R.C.) 35, 36 (1961)
chemistry and technology (N.R.R.C.) 32 (1961)
collection 156, 157 (1961)
from newer clones 62 (1960)
low ammonia 16, 39 (1960)
preservation with boric acid 17, 107 (1960)
preservation, short-term 87 (1960)
removal of pigments 80 (1960)
shipments of boric-acid preserved 25, 108 (1960); 66, 191 (1961)
vulcanisation for SP rubber production 26 (1960)
Latex concentrate, improving 64 (1960)
Latex concentrate, quality 60 (1960)
Latex flow stimulation by plant growth regulators (N.R.R.C.) 4 (1961)
Leaf sampling 113 (1960)
Leguminous creepers *see* Cover plants
Lime and molybdate interactions in the nutrition of *Centrosema pubescens* and *Pueraria phaseoloides* 106 (1960)
Limestone 104 (1960); 185 (1961)
Loss of Ammonia from Surface Applications of Urea Fertilisers 180 (1961)
Low Ammonia Latices: The Use of Boric Acid 16 (1960)
Low ammonia preservation of latex (*see also* Boric acid) 89 (1960)
Low ammonia preservation of latex in Malaya, types of 16 (1960)
Low Choong San 195 (1961)

Machining and rapid drying 33 (1960)
Machining intensity and serum 33 (1960)
Magnesium 185 (1961)
Magnesium limestone and yield 105 (1960)
Magnesium limestone, an experiment with 103 (1960)
Magnesium limestone, effect on growth and yield of dry rubber 104 (1960)
Magnesium sulphate 100 (1960)
Main planting areas in Malaya, a comparison of 78 (1960)
Majumder, Shyamal Kumer 42 (1961)
Malayan Rubber Fund Board 105, 106 (1961)
Malayan rubber production 1960-1970 43 (1961)

Manganese:
deficiency correction 63, 193 (1961)
mixtures 65 (1961)
sulphate 64 (1961)
Mann, C.E.T. 69 (1961)
Mann, C.E.T., retirement 46 (1960)
Manual of Rubber Planting (Malaya) 1958 by A.T. Edgar 126 (1960)
Manures *see* Fertilisers
McCulloch, G.C. 14 (1960)
McDonnell, J.J. 45 (1960)
McEwen, J.F. 70 (1960)
Mechanical clearing 42 (1960)
Mechanical scarification, seeds for cover crops 95 (1960)
Mechanical stability (M.S.T.) 60 (1960)
Melastoma malabathricum 190 (1961)
Microbiology of Latex I, II (N.R.R.C.) 36, 37 (1961)
Middleton, K.R. 106 (1960)
Mikania scandens 35, 36 (1960); 190 (1961)
Milling PA 80 coagulum 28 (1960)
Mixed and Compound Fertilisers 175 (1961)
Moisture content, drying sheet rubber 21 (1960)
Molybdate and lime interactions in the nutrition of *Centrosema pubescens* and *Pueraria phaseoloides* 106 (1960)
Mooney stabiliser 192 (1960)
Muthurajah, R.N. 70 (1961)

Narayanan, R. 114 (1961)
'Natural' covers: mixture of *Trema, Ficus, Macaranga, Hornstedtia* spp. and others 36 (1960)
Natural Rubber Research Conference 89, 111 (1960)
Natural Rubber Production (N.R.R.C.) 7 (1961)
Natural Rubber Research Conference, 1960. (N.R.R.C.) A summary of the work of the Conference 5 (1961)
Nephrolepsis sp. 161 (1961)
Ng, E.K. 114 (1961)
Nitrogen *see also* Fertilisers:
availability, carbon/nitrogen ratios 36 (1960)
availability to rubber plant 36 (1960)
content of leguminous creepers 36 (1960); 185, 187 (1961)
Nomograph, sheet rubber drying 45 (1960)
Nutrients *see* Plant nutrients
Nutrition I, II (N.R.R.C.) 8, 9 (1961)

Oidium heveae 3, 7 (1960)
Owen, G., retirement 90 (1960)

PA 80:
coagulum milling 28 (1960)
cost of production 31 (1960)
crepe and compressed crumb packing 29, 30 (1960)
finishing and packing 29 (1960)
optimum drying conditions 29 (1960)
production 26 (1960)
production, shipments and use during 1960 81, 82, 83 (1961)
recommended packing method 29 (1960)
Pale crepe production:
choice of clones for 84 (1960)
removal of pigments from latex 80 (1960)
suitability of latex from some of the newer clones 84 (1960)
Paraquat 160, 190 (1961)
Particle size of *Hevea* latex, soap titration method of estimating 88 (1960)
Paspalum conjugatum 189 (1961)
Patent: Boric Acid Latex 107 (1960)
Patents:
applications 192 (1961)
R.R.I.M. 192 (1961)
use of combinations of EDTA 16, 17 (1960)
Patents: Low Ammonia Preservation of Latex 89 (1960)
Patenting of zinc dialkyl dithiocarbamates by the General Latex Corp. 17 (1960)
Pebbles and heat scorch 125 (1960)
Pests and Diseases, I, II (N.R.R.C.) 24 (1961)
pH and the availability of phosphate and iron 102 (1960)
Phaseolus angularis Wight (Adzuki bean) 122 (1960)
Phaseolus calcaratus Roxb. (Rice bean *kachang sepalit*) 119 (1960)
pH:
of soil 98 (1960); 180 (1961)
optimum range for *Hevea* 99 (1960)
scale and soil pH 100 (1960)
Physiological diagnosis 112 (1960)
Phosphate 102 (1960)
Phosphorus 185 (1961)
Pigments, removal of from latex for pale crepe production 80 (1960)
Planters' Bulletin in Other Languages 70 (1961)
Planters' Conference 71 (1961)
Plant nutrients (*see also* Fertilisers):
calcium 185 (1961)
content, variation of legume covers 186 (1961)
effect of phosphatic manuring of leguminous cover plants 188 (1961)
magnesium 185 (1961)
manganese deficiency correction 63 (1961)
manganese deficiency symptoms 63 (1961)

nitrogen 185 (1961)
phosphorus 185 (1961)
potassium 185, 187 (1961)
return to soil by deteriorating legume covers 184 (1961)
Plant nutrition (N.R.R.C.) 8, 9 (1961)
Planting density 141
Planting density, effect on wind damage 166 (1961)
Planting Material Used in Malaya 1955-8 72 (1960)
Planting Material Used in Malaya 1959 54 (1961)
Planting material:
classification method 47 (1961)
seed 53 (1961)
yields 143, 144 (1961)
used on estates 75 (1960)
Planting, progress in new planting and replanting 23 (1960)
Planting Recommendations 1961-62 47 (1961)
Planting recommendations 1959-60, amendments 13 (1960)
Planting recommendations 1959-60, further amendments 67 (1960)
Poison:
2,4,5-T, tree poison 40 (1960)
Poisoning of stumps and trees 39, 41 (1960); 81, 167 (1961)
Pollarding and pruning clone RRIM 501 91 (1961)
Pollarding and Pruning in Mature Stands of Clone RRIM 501 91 (1961)
Potassium 100 (1960); 175, 185, 187 (1961)
Preparation and Use of Natural Rubber and Latex (N.R.R.C.) 27 (1961)
Preparation of vulcanised latex 26 (1960)
Preservation of latex with boric acid 17 (1960)
Preservation of natural latex, short-term 87 (1960)
Preserved latex, characteristics of 17 (1960)
Preserved latex quality with boric acid preservation 18 (1960)
Processing Aid 80 *see* PA 80
Proceedings of the Natural Rubber Research Conference, 1960 1, 174 (1961)
Production of Malayan rubber 1960-1970 43 (1961)
Production of Malayan smallholders' rubber 45 (1961)
Production of natural rubber (N.R.R.C.) 7 (1961)
Pruned (RRIM 501) trees and bark damage 94 (1961)
Pruning and pollarding clone RRIM 501 91 (1961)
Pueraria phaseoloides 36, 106 (1960)
Phytophthora palmivora 41 (1961)

Ready rub 115 (1960); 103 (1961)
Re-formation of advisory service, 1958 1 (1960)
Removal of Pigments from Latex for Pale Crepe Production 80 (1960)

Reorganisation of Rubber Research 104 (1961)
Replanting and new planting progress 23 (1960)
Replanting on small estates 91 (1960)
Replanting survey by R.R.I.M. on smaller estates 92 (1960)
Research Developments at the R.R.I.M. 65 (1960)
Rhizobium culture and sowing 98 (1960)
Rhizomorphs 72 (1961)
Rhizomys sumatrenis 20 (1960)
Riepma, P. 70 (1961)
Rock phosphate 100, 106 (1960); 175, 181, 185, 186 (1961)
Rock phosphate, for seedling rubber 106 (1960)
Root disease:
  clonal resistance 44 (1960)
  collar inspection 167 (1961)
  control 7, 42, 72 (1960)
  cover crop effect 76 (1961)
  detection 74 (1961)
  disposal of source of infection 76 (1961)
  foliage identification 168 (1961)
  influence of soil conditions 169 (1961)
  stump poisoning 167 (1961)
  Tillex 168 (1961)
  trenching 77, 78, 79 (1961)
Root Disease Control 72, 167 (1961)
RRIM 600 series Clones 8 (1960); 58 (1961)
RRIM 600 series Clones in Estate Trials 49 (1960)
R.R.I.M. New Buildings 68 (1960)
Rubber cultivation and soil reaction 98 (1960)
Rubber output from smallholdings 45 (1961)
Rubber research reorganisation 104 (1961)
Rubber Research Institute of Malaya reorganisation 107 (1961)
Rubber technology (N.R.R.C.) 28, 32 (1961)
Rubber Technology Conferences 47 (1960)

Salgado, C.A.K. 69 (1961)
Santobrite and methyl selenac 17 (1960)
Santobrite latex 16 (1960)
Scrap percentage 156 (1961)
Secondary Leaf Fall and South American Leaf Blight 3 (1960)
Seed germination of some tropical legumes 88 (1960)
Seed, source of planting material 53 (1961)
Seed Treatment and Sowing Methods for Cover Crops 94 (1960)
Seedlings (*see also* Clonal seedlings) use in Malaya 75 (1960)
Sekhar, B.C. 70, 88, 130 (1960)
Sericothrips dorsalis 3, 6 (1960)
Sethu, S. 69 (1961)

Sheet production; rapid drying 33 (1960)
Sheet Production, Rapid Drying Needs Good Machining 33 (1960)
Sheet rubber, drying:
  advantage of two stage drying 22 (1960)
  blister-formation 21 (1960)
  care in machining 33 (1960)
  nomograph 45 (1960)
  technological properties 22 (1960)
  temperature gradient 22 (1960)
Shipments of Boric Acid Latex 191 (1961)
Shipments of boric acid preserved latex 19, 25 (1960)
Skim latex treatment 66 (1960)
Smallholders, use of planting material 79 (1960)
Sodium arsenite:
  herbicide 112, 160, 189 (1961)
  tree poisoning 38, 41 (1960)
Sodium nitrate 100 (1960)
Sodium pentachlorphenate 16 (1960)
Soil (*see also* Fertilisers):
  acidification by mixed and compound fertilisers 179 (1961)
  acidity 98, 102 (1960); 179, 180 (1961)
  Batu Anam 166 (1961)
  carbon/nitrogen ratio 38 (1960)
  choice of appropriate cover plants 161 (1961)
  clay fraction and pH 98 (1960)
  coastal clay 161 (1961)
  decomposition 38 (1960)
  effect on wind damage 165, 166 (1960)
  fertility 38 (1960)
  influence on root disease 169 (1961)
  Malacca series 166 (1961)
  Rengam series experiment 36 (1960)
  return of nutrients by leguminous covers 184 (1961)
Soil Reaction and Rubber Cultivation 98 (1960)
Soosai, J.S. 195 (1961)
South American leaf blight and secondary leaf fall 3 (1960)
Sowing methods and seed treatment for cover crops 94 (1960)
SP:
  ADS 81, 82, 83 (1961)
  brown crepe 26 (1960); 81, 82, 83 (1961)
  crepe 81, 82, 83 (1961)
  masterbatch 26 (1960)
  RSS 81, 82, 83 (1961)
  rubber premium 84 (1961)
  rubber, process of production 26 (1960)
  rubber progress report 32 (1960)
  rubber, shipment and demand 31 (1960)

SP Rubber During 1960 81 (1961)
SP Rubber, Progress in 1959 31 (1960)
Stimulation of latex flow by plant growth regulators (N.R.R.C.) 4 (1961)
Stimulation of yield *see* Yield stimulation
Stimulation of Yield: A Comparison of Proprietary Yield Stimulants 114 (1960)
Stimulex 68, 115 (1960; 101, 142 (1961)
Stump and tree poisoning 38 (1960); 81, 167 (1961)
Stumps, decay 43 (1960)
Stumps, surface treatment of 43 (1960)
Stylosanthes seed treatment 95 (1960
Substitutes for Sodium Arsenite 189 (1961)
Summaries of the Proceedings of the Natural Rubber Research Conference, Kuala Lumpur, 1960 1 (1961)
Superior Processing Rubber (*see also* SP rubber) 31 (1960); 81 (1961)
Superphosphate 100, 106 (1960)
Superphosphate as source of phosphorus 106 (1960)
Survey of Commercial Yields in Relation to Tapping Systems 117 (1961)

Tambling, Joyce 70 (1960)
Tan Beng Lin 114 (1961)
Tapping:
  costs 139, 146 (1961)
  girth at opening 140, 146, 149, 156, 174 (1961)
  height of opening 156 (1961)
  ladder 159 (1961)
  periodic 150 (1961)
  scrap percentage 156 (1961)
  second and subsequent panels 153 (1961)
  task 137, 141, 148 (1961)
  yield per tapper 116, 119, 123, 127, 133, 140 (1961)
  young rubber 149 (1961)
Tapping of Young Rubber 149 (1961)
Tapping: Yield Stimulation I, II (N.R.R.C.) 11, 14 (1961)
Tapping systems:
  effect on brown bast 134, 138 (1961)
  effect on girth 150 (1961)
  effect on latex quality 60 (1960)
  effect on yield stimulation 155 (1961)
  for clonal seedlings 154 (1961)
  periodic 87, 123, 150, 157 (1961)
  survey in relation to yields 117 (1961)
Tapping Systems and Yield Stimulation on Three Estates 139 (1961)
Task size 137 (1961)

TCR 85 (1961)
TCR in Indonesia 85 (1961)
Technical Advisory Services 110 (1961)
Technical service to Malayan rubber manufacturers 71 (1960)
Technically Classified Rubber *see* TCR
Termite Control 109 (1960)
Termites 68 (1961)
The Natural Rubber Research Conference 107 (1960)
The Nitrogenous Content of Leguminous Creeping Covers 35 (1960)
Thinning young rubber 44 (1960)
Tillex 168 (1961)
Time and motion study 138 (1961)
Trapping Cockchafer Beetles 122 (1960)
Traps for cockchafer beetles 123 (1960)
Tree and Stump Poisoning 39 (1960)
Tree injection 113 (1960)
Tree poison, 2,4,5-T 40 (1960)
Tree poisoning, method 41 (1960)
Trenching in root disease control 77, 78, 79 (1961)
Tropical legumes, seed germination of some 88 (1960)
Tunnel drier 22 (1960)
Two Phaseolus Species of Interest 119 (1960)
2,4-D, *see* Yield stimulation
2,4,5-T *see* Herbicides; Yield stimulation; *and* Tree poison

Urea 100 (1960); 180 (1961)

Variations in Field Latex and Influence on Latex Concentrate Quality 60 (1960)
Vegetation of rubber plantations 87 (1960)
Vegetative propagation (N.R.R.C.) 19, 21 (1961)
Volatile fatty acid No. (V.F.A. No.) 60, 61, 63, 64 (1960)
Vulcanisation of latex compounds 18 (1960)
Vulcanised latex, blending and coagulation 27, 28 (1960)
Vulcanised latex preparation 26 (1960)
Vulcanising dispersion preparation 26, 27 (1960)
Vulcanising field latex, use of metrolac 27 (1960)

Wastie, R.L. 195 (1961)
Watson, G.A. 106 (1960)
Webster, C.C. 128 (1960); 69 (1961)
Weed control *see* Herbicides
Weed Control and Herbicides 160 (1961)
Westgarth, D.R. 22 (1960)
Wind damage 10, 13, 53 (1960); 183 (1961)

Wind damage:
bending 163 (1961)
Editorial 173 (1961)
effect of soils type 165 (1961)
GT 1 174 (1961)
influence of cover crops 162, 163, 183 (1961)
planting distance, effect 166 (1961)
pruning 91, 164 (1961)
RRIM 501 174 (1961)
soils effect 165, 166 (1961)
timber strength 163, 164, 173 (1961)
trunk snap 163, 183 (1961)
Wong, J.P.C. 195 (1961)
World consumption of boric acid preserved latex 19 (1960)
Wren, W.G. 69 (1961)
Wycherley, P.R. 87, 88, 100 (1960)

Yellow pigment, removal 80 (1960)
Yeoh Chong Hoe 42 (1961)
Yield:
average per tapping of pruned, pollarded and control RRIM 501 clones 93, 96, 98 (1961)
clones and clonal seedlings 119, 122, 125, 129, 136 (1961)
high yielding material 24, 91 (1961)
increase 24, 105 (1960)
PB 501 10 (1960)
RRIM 600 series 50 (1960); 58 (1961)
RRIM 600 to 618 8 (1960); 59 (1961)
RRIM 619-630 10 (1960); 61 (1961)
trials of promising clones *Tables 1, 2, 3* 51, 52, 53 (1960)
Yield per tapper *see* Tapping
Yield stimulants, a comparison of 68, 114 (1960)
Yield stimulants, cost of 117 (1960); 103 (1961)
Yield stimulation:
ABC system 157 (1961)
effect on latex 61 (1960)
effect on yield 115 (1960); 101, 137, 142 (1961)
method of application 146 (1961)
relation to tapping system 11 (N.R.R.C.), 139, 154, 155, 158 (1961)
scraping methods 100, 101 (1961)
Yield trends 44 (1961)
Yield, unselected seedlings 24 (1960)
Young seedlings, susceptibility to drought 95 (1960)

International Rubber Conference, Paris
14—18 May, 1962

An International Rubber Conference is being organised by the Institut Francais du Caoutchouc with the support of the International Rubber Research and Development Board. It will be held in Paris on 14-18 May, 1962.

The main aims of the sponsors of the Conference will be to make known the latest developments in the science and technology of the production and preparation of natural rubber and at the same time to compare the qualities of natural and synthetic rubber.

The Conference will consist of six sessions as follows:

1. Position of rubber (natural and synthetic) in world economy
2. Natural rubber production
3. Physics and chemistry of natural rubber
4. Improvement of the quality of natural rubber, including special natural rubbers

5 and 6. Comparison of natural and synthetic rubbers.

Further information may be obtained from the Secretariat of the International Rubber Conference, c/o M. G. Daugy, 42 rue Scheffer, Paris (16).

OUR COVER PHOTOGRAPH SHOWS THE APPLICATION OF FERTILISERS ALONG THE PLANTING ROW, EIGHT MONTHS AFTER BUDDING.

Photo C.T.Y.

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